Renewable and Sustainable Energy Reviews 16 (2012) 1907–1915

Contents lists available at SciVerse ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Review on wind power development and relevant policies in China during the 11th Five-Year-Plan period

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ARTICLE INFO

Article history:
Received 19 September 2011
Accepted 8 January 2012
Available online 18 February 2012

Keywords:
Wind power
Energy policy
Renewable energy
China

ABSTRACT

Since 2005, there has been dramatic progress in China's wind power industry. The annual growth rate of newly constructed capacity reached a miracle of 105% and the total installed capacity has increased from 1.27 GW in 2005 to 44.73 GW in 2010, which has exceeded the target of China's energy long-term planning for 2020. During the 11th Five-Year-Plan (FYP), the Chinese government has issued a series of polices to promote and regulate the development of wind power industry, which is the underlying force driving its rapid development. This paper is a systematical review on the current status and policies of wind power industry in China. Firstly the current status including achievements and shortcomings is presented, and then the relevant polices and regulations released during the period of 11th FYP are reviewed. Meanwhile, the main approaches of the policies and regulations in promoting the development of wind power industry are discussed and the issues of the current policies are analyzed. Finally, the paper concludes on the perspectives of wind power policies in China.

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doi:10.1016/j.rser.2012.01.031

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1. Introduction

Since China adopted the policy of reform and opening-up in late 1978, the whole world has witnessed the miracle of 9.8% annual GDP growth for more than three consecutive decades [1]. Especially in the period of the 11th Five-Year-Plan (FYP), facing the disadvantageous impact of financial crisis, China's GDP has also kept a high speed growth. During the period of 11th FYP, the annual GDP growth rate of China has been up to 11.2% [1], which is not only far higher than the world average but also 1.4% higher than its average GDP growth during the 10th FYP.

Not only China's economy has advanced by leaps and bounds, but this development is also accompanied by high energy consumption. During the period of 11th FYP, China's power consumption has shown clear ascendant trend with the average growth rate at 11.2% [2], equal to economic growth rate in this period. In addition, during this period, China's power industry has developed rapidly with an annual installed capacity growth rate of 13.2% (as shown in Fig. 1), significantly higher than that of economic growth during the same period [1,2]. But the rapid growth of power capacity still cannot meet the needs of economic development. From the spring of 2011, there is power shortage in many provinces even during the off-season. According to the information from the national grid corporation, Hunan province needs stable daily power load of 14 gigawatts (GW) to maintain daily life and production, but the available power load is only 10 GW with gap of 4 GW; and the gap of power supply to demand in Zhejiang Province may be up to 4 GW in summer peak time, and it may grow to 8.9 GW in 2012 [3]. China Electricity Council's survey data also indicate that the gap of power supply may expand to 30–40 GW during the 2011 summer [4]. The districts in shortage are mostly concentrated in the north, east and south China and other economically developed areas. Therefore, the long-term economic growth still needs a rapidly grow in power industry.

China's electric power production is highly dependent on coal. By the end of 2010, the coal-fired units accounted for 73% of the total installed capacity and generated 81% of the total electricity, which are far above the world average levels [5]. China's coal reserve ranks third in the world of proved reserves, just behind the United States and Russian Federation. However, taking into account of the largest population of 1.345 billion, the Chinese per capita coal resource is only 70.4% of the global average, while that of petroleum and natural gas are just 6.2 and 6.8% of world average respectively [6]. All fossil reserves are in a low level in the whole world, so China is also the country with serious energy shortage.

In addition, large-scale of coal mining and burning has caused serious environmental problems, including ground subsidence, destroyed ground water systems, expanded acid rain area, and massive emission of greenhouse gas and solid waste. In 2009, the national total industrial emission of sulfur dioxide is about 16.9 millions tons, but power industry alone accounted for 9.3 million tons; the total carbon dioxide emissions are about 60 tonnes, and power industry accounted for 41% [7].

Rapid economic growth, continued demand for energy and increased requirement for energy saving and emission reduction promote Chinese government to adjust energy structure continually and increase the proportion of clean energy in the energy consumption structure. With the rapid growth in energy demand, the Chinese government has formulated a series of policies to promote renewable energy industries in recent years. According to China's medium-and-long-term nuclear and renewable energy planning issued in 2007, by 2020, the installed nuclear power capacity will exceed 40 GW, the hydropower capacity will reach 300 GW and wind power capacity will increase to 30 GW (as shown in Table 1) [8,9].

The relevant studies have shown that a series of laws and regulations released during 11th FYP have played an important role in promoting renewable energy industries development and technological progress [10–15]. So China's various non-fossil energy industries have grown rapidly in the past years, and energy structure has also been gradually optimized, but some new problems may hinder the optimization. In March 2011, a great earthquake occurred in Japan, it caused huge damage to nuclear power plants and triggered a serious nuclear leakage in Fukushima. After this incident, the Chinese government has suspended the approval of new nuclear power projects and launched rigorous orders to check the safety of nuclear power projects [16]. Maybe this incident changes the trajectory of nuclear power development and further affects the China's strategic of energy structure adjustment. In addition, the impact of hydropower station on ecology and environment

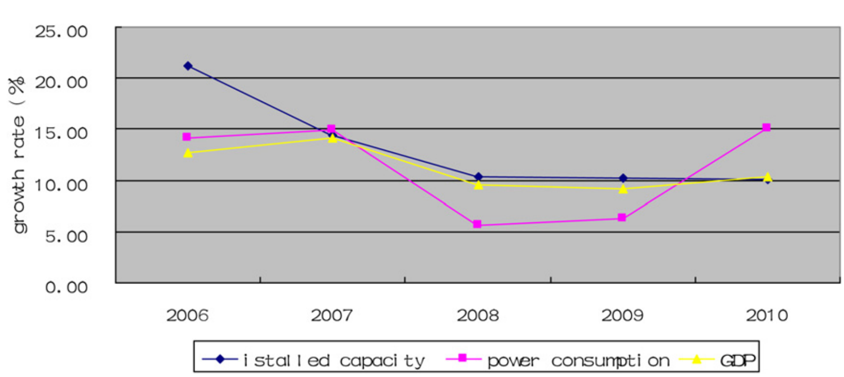


Fig. 1. Annual growth rate of installed capacity, power consumption and GDP from 2005 to 2010.
Source: NBS for GDP data [1] and CES for other data [2].

Table 1
China's medium- and long-term planning for nuclear and renewable energy development (Unit: GW).

	Global development status 2005	Resource potential in China 2005	China's development status 2005	China's development status 2010	China's development goals 2010	China's development goals 2020
Hydropower	850	540	117	213	190	300
Nuclear energy	369		9.07	10.8	10	40
Wind power	60	1000	1.26	44.7 (31)	5	30
Bio-mass	50	1G toc	2		5.5	30
Solar energy	0.4		0.07		0. 3	1.8

Source: National Development and Reform Commission [8,9].

also attracts more attention of experts and the masses; the decision to build new hydropower stations will become more cautious in China. Therefore, we can infer that Chinese government is bound to re-adjust the development goals of new energy industry and refocus on other clean energy sources to achieve the goal of energy structure adjustment.

China is rich with wind power resources. According to the information of China Meteorological Administration, onshore wind power resources available for economic development and utilization at the altitude of 10 m are about 200 GW, at the altitude of 50 m the resources available are more than 500 GW, and offshore wind power resources in coastal areas aggregate 750 GW [17], Therefore, wind power is the important, feasible solution for China's energy sustainable development. During the period of 11th FYP, the development of China's wind power industry is spectacular, the total installed capacity in the end of 2010 has reached 44 GW, much more than the planned target in of 30 GW for 2020 [5–8]. Undoubtedly, the rapid development of wind power is closely related with policy support during the periods, so it has great significance to analyze energy policy issued in the 11th FYP for the future development.

The layout of the paper is as follows. Firstly Section 2 presents the status quo of wind power industry during the 11th FYP, discussing both achievements and shortcomings. Then Section 3 will give an overview of the relevant policies and regulations formulated during the past years. In Section 4, the measures to promote wind energy industry development will be discussed. In Section 5, the underlining factors that hinder the development of wind power industries will be discussed and Section 6 is the policy outlook.

2. The status quo of China's wind power industry development during the 11th FYP

2.1. The achievements

2.1.1. Installed capacity and power generation

Since 2005, China's wind power industry has made progress at an unprecedented pace with the total installed capacity increasing from 1.27 GW in 2005 to 44.73 GW in 2010, which has exceeded the requirement of China's energy long-term planning for 2020 [1–8]. The average annual growth rate during the 11th FYP is up to 105%, which is 7 times higher than the growth rate of total power capacity and 8.4 times higher than the GDP growth rate for the same period. In addition, the new added wind power capacity annually has also shown a growth trend (albeit weakened since 2009) with an average annual growth rate of 110% (Fig. 2) [1,2]. In 2010 the wind power generation accessed to grid is more than 50 billion kW, which is 32 times higher than in 2005 [1,2]. Globally, the China's share of wind power installed capacity has been significantly heightened. In 2005, the share of new added wind power installed capacity in the world is 5.3% and the rank is sixth; the share of total wind power installed capacity is only 2.1% and the rank is eighth [18]. But in 2010, the share of china's new added wind power installed capacity in the world is up to 48.1% and the rank has risen to the top; the share of total wind power installed capacity is up to 22.4% and the rank has also risen to the top [18]. So China has surpassed the U.S. and became the leading nation of wind installed power capacity (Table 2). From the perspective of the geographical distribution, the extent of regional distribution gradually enlarged. In 2005, there are 59 wind power plants distributed in 15 provinces all over the country, but in 2010 the number of wind plants has exceeded 500 and the extent of regional distribution has enlarged to 24 provinces. Particularly, the installed capacity in east China has surpassed 8 GW, which can effectively help ease the tension of power shortage in this region [1,2].

2.1.2. The technical efficiency of installed wind power

With the rapid development of China's wind power industry, the efficiency of installed wind power has also been improved during the 11th FYP. The main representation of the improvement is the increasing of the unit capacity and the expanding scale of the wind power plants. In 2005, the rate of new added megawatt-level units of wind turbines is only 21.5%, the average unit capacity of new added wind turbine is only 0.86 MW, and the average unit capacity of total wind turbine is only 0.68 MW [18]. However, larger megawatt-level units of wind turbine has become the mainstream when building new wind power plants in recent years, about 9793 wind turbines of 1.5 MW scale have been installed in 2010, accounting for 77.6% of newly added capacity. About 980 wind turbines of 2 MW scale have been installed, accounting for 10.4% of new added installed capacity [18]. Moreover, wind turbines of 3 MW scale begin to be gradually used in many big wind power plants. In 2010, the average unit capacity of new added wind turbine has been up to 1.47 MW and the average unit capacity of total wind turbine has exceeded 1.3 MW (Fig. 3) [18]. Meanwhile, the scale of wind power plants is also gradually expanded. At 2010 the average installed capacity of each wind plant is 87 MW, that is 4 times greater than that in 2005 [18]. At the same time, the planning of seven huge wind power bases of 10 GW scale has been completed and many of them are finished with initial construction (Table 3). Improved technical efficiency cannot only enhance land using efficiency and save land resources, but also reduce the cost of building and be conducive to the construction of power grids to facilitate the access rate of wind power.

2.1.3. The economical efficiency of wind power and market development

During the 11th FYP, the market witnesses the dramatic variation of wind turbine price. In 2004, the average price was 4800 Yuan/kW, but the price increased to 6200 Yuan in early 2008. However, the price began to gradually decline from the Second half of 2008. Especially in 2010, the price began to decline sharply. By the end of 2010, the average turbine price has been reduced to 3500 Yuan/kW [20] (Fig. 4). According to the wind turbine price, wind generation cost can be reduced to 40 cents/kW, close to the coal generation cost. Although the price of wind turbine decreases rapidly, the wind turbine manufacturers still have enough profit margins. For example in 2010, the net profit of Goldwind Science &Technology Company is 758 million, 4.9% higher

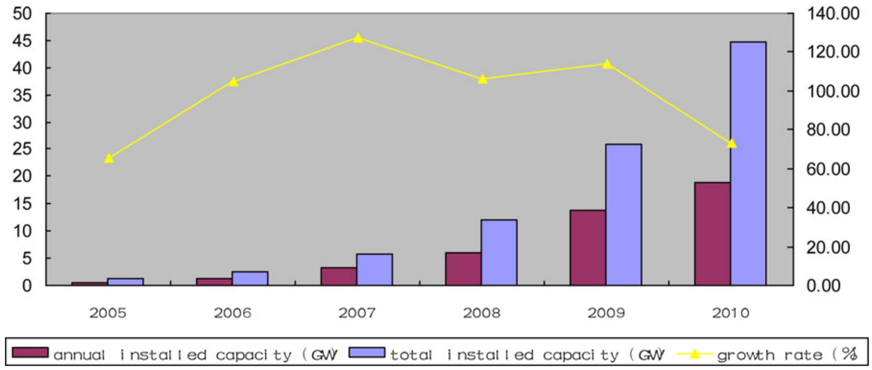


Fig. 2. Annual wind power installed capacity and growth rate during the 11th FYP.

Source: Chinese Wind Energy Association [18].

Table 2
The share of China in world wind power installed capacity.

	2005	2006	2007	2008	2009	2010
The share of new added installed capacity (Rank)	5.3% (6)	8.9% (5)	16.8% (3)	23.3% (2)	36.3% (1)	48.1% (1)
The share of total installed capacity (Rank)	2.1% (8)	3.5% (6)	6.3% (5)	10.1% (4)	16.3% (2)	22.4% (1)

Source: Chinese Wind Energy Association [18].

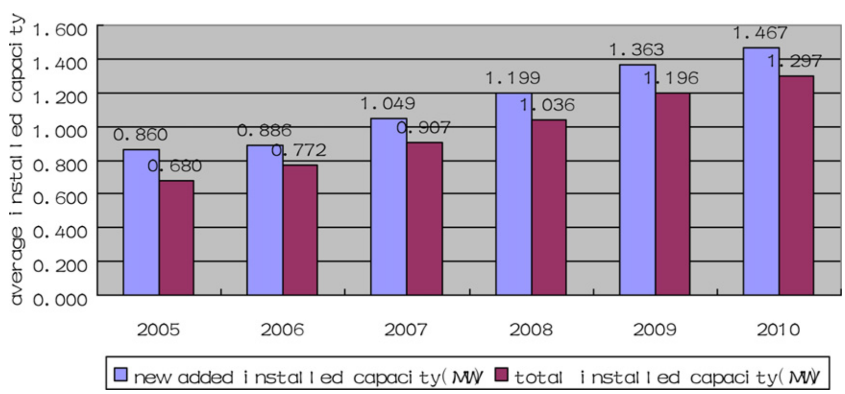


Fig. 3. Changing trends of wind power unit capacity during the 11th FYP.

Source: Chinese Wind Energy Association [18].

than that of last year, and the undistributed profit is 2.38 billion, with the annual increase of 9.35% [21]. The factor underlying decreasing wind turbine is that the competition in wind turbine market is becoming intense. The competition on one hand leads to market price closer to manufacturing costs; on the other hand it promotes the manufacturing technology to mature. In recent years, the level of standardization and normalization of wind turbine manufacturing process has been significantly enhanced, which effectively reduces the production cost. In 2005, the market share of top five firms is 97.4%, but the figure has lowered to 71% in 2010 [18]. Lower industry concentration ratio illustrates that the monopolization power is weakening and market competition is intensifying.

2.1.4. The domestic manufacturing of wind power equipment

During the 11th FYP, China's wind turbine manufacturing industry has been rapidly developed and manufacturing level has been greatly improved. In 2005, more than 70% of the wind power equipment was imported, but the domestic manufacturing level of newly added wind power equipment has grown up to 90% in 2010

Table 3
Overview of seven wind power generation base.

Seven wind power generation base	Finished installed capacity by 2010	Installed capacity of constructing	Annual goal of installed capacity	Planning goal in 2020
Western Inner Mongolia	6.3 GW	1.12 GW	3.2 GW	38 GW
Eastern Inner Mongolia	3.82 GW	1.8 GW	1.7 GW	21 GW
Northern Hebei	3.58 GW	850 MW	1 GW	14 GW
Jilin	2.02 GW	260 MW	1.9 MW	21 GW
Jiuquan, Gansu	1.34 GW	3.8 GW	2 GW	22 GW
Jiangsu coast	1.28 GW	220 MW	950 MW	11 GW
Hami, Xinjiang	495 MW	49.5 MW	1 GW	11 GW

Source: China Wind Power Outlook [19].

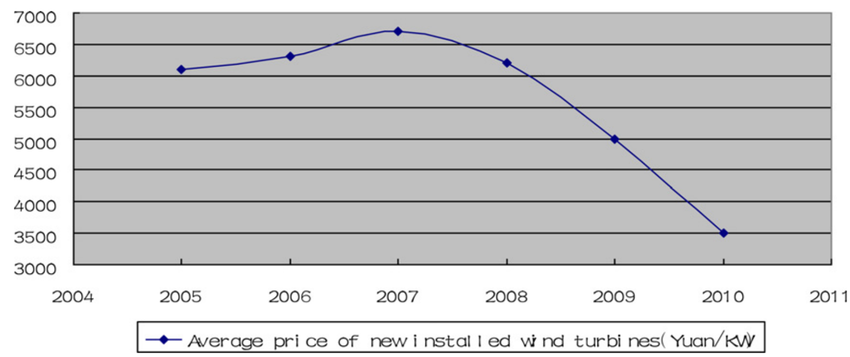


Fig. 4. Change of wind turbine price during the 11th FYP.

Source: Chinese Wind Energy Association [18–20].

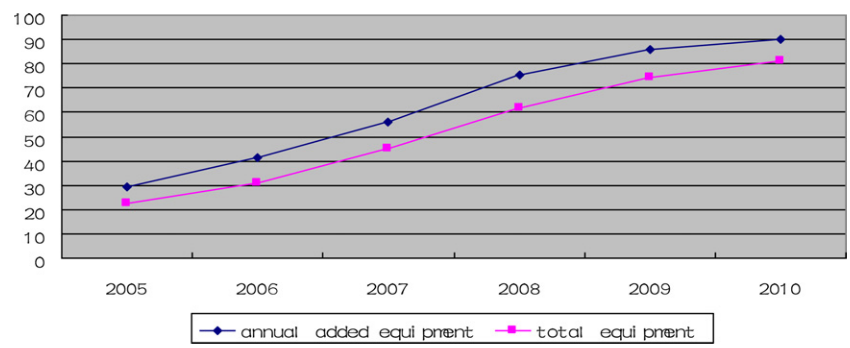


Fig. 5. Changing trends of domestic manufacturing level during the 11th FYP.

Source: Chinese Wind Energy Association [18–20].

(as is shown in Fig. 5) [20]. As the market continues to expand, there are more than 10 manufacturers to achieve a large-scale production, among which Goldwind Science & Technology Company, Sinovel Wind Group Company and other five companies have been among the world top 15, and Sinovel Wind Group Company has become the second largest power equipment supplier in the world. Through the technology accumulation and continuing capital investment for many years, the production level of domestic manufacturers has continuously improved. They are able to produce not only 1.5, 2 and 3 MW levels wind turbine, but also 5 MW level of huge wind turbine and offshore wind turbine. At present, domestic company can produce all the important components of wind power system and manage to export wind power equipments to the United States, Belarus, Chile, Cuba and other countries [22].

2.1.5. The development of offshore wind power

Although the inland projects are the main focus of wind power until now, it is an important direction to develop offshore wind power, because southeast coastal area of China is not only rich in offshore wind power resource, but also close to power load center and has additional technical-economic advantage. In July 2010, Donghai Bridge Offshore Wind Power Plant in Shanghai, as the first offshore wind power project in China and also Asia, has been completely built and accessed to the grid, an indication that China has successfully taken the first step in the development of offshore wind power (Fig. 6). In the process of the project, a wealth of experience has been accumulated and will be an important reference for later offshore wind power projects. After that the government launched the first concession tender of 1 GW offshore wind power project in Jiangsu Province. The construction of offshore wind power will contribute significantly to the development of renewable energy.

2.2. The shortcomings

2.2.1. Deficiency in supporting facilities and low grid-access rate

During the 11th FYP, even though the wind power industry has developed rapidly, the relevant supporting facilities are seriously insufficient, leading to the low grid-access rate of wind power. From 2005 to 2007, the grid-access proportion was only about 50%. From 2008, though the proportion has improved significantly, it is only about 70% [18], so about 30% of wind turbines are in the condition



Fig. 6. The turbine of Shanghai Donghai Bridge offshore wind power plant.

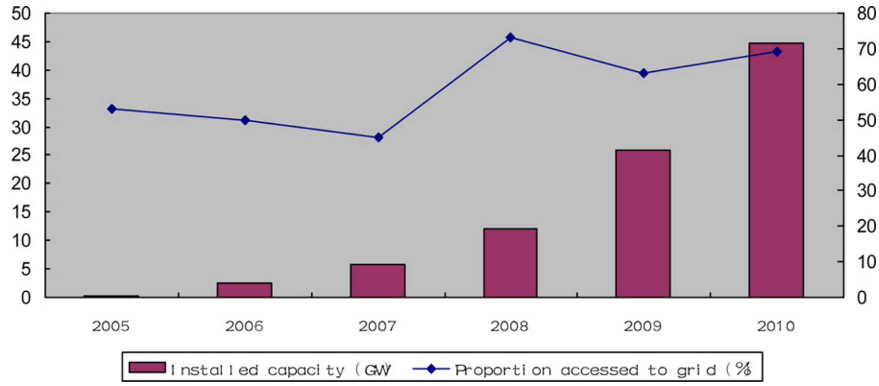


Fig. 7. Total installed wind power capacity and proportion accessed to grid.

Source: The State Electricity Regulatory Commission.

of idling and cannot be utilized (Fig. 7). There are three reasons why it is difficult to access the wind power into the gird. First of all, the growth of installed capacity is too fast and far beyond the pace of plan updating. Secondly, the planning of power grid is not consistent with that of wind power plants. It is the command of the National Development and Reform Commission (NDRC) that all wind power plant projects above 50 MW scale must be approved by NDRC and implemented by national planning, but in fact many projects larger than 50 MW are usually split into small projects so that they can be approved by local government instead of NDRC and therefore are not implemented according to national planning. The aftermath is the actual scale of wind power plants is much larger than the planning issued by NDRC. However the grid development planning is based on the wind power projects planning issued by the NDRC and hence comes the inconsistency. Finally, due to the high wind power price accessed to the grid, the instability of power load and lack of relevant national incentives, the grid company lacks initiative of promoting the power grid construction to facilitate wind power access.

2.2.2. Possible overcapacity and lack of core technology

During the 11th FYP, domestic wind turbine manufacturing industry has been rapidly developed, but symptoms of overcapacity have emerged. By the end of 2010, there are up to 70 domestic wind power system manufacturers, more than the sum of the rest of the world manufacturers. In all of the domestic manufacturers, two-thirds of them can annually produce less than 100 units of 1.5 MW level turbines, and only Goldwind Science & Technology Company, Sinovel Wind Group Company and Dongfang Turbine Company can produce more than 500 units [23]. Most of the manufacturing enterprises do not have core competency and are in low efficiency, which not only results in repeated construction and great waste of resources, but also causes vicious competition. Furthermore, lack of key technology makes the quality of the wind turbine to remain at a low level, and then leads to the quality problems and technical troubles in the process of operation.

3. Overview on wind power policies and regulations in China during the 11th FYP

In 2005 the *Renewable Energy Law* was issued, which has proposed several measures to promote the development of wind power industry. (1) The law requires the grid company to purchase all renewable energy power accessed to the grid; (2) the law first puts the scientific technology and industrialization development of renewable energy into the priority field; (3) to solve the high price problem of wind power, the law proposes that excess section of wind power price accessed to the grid compared with conventional energy can be shared in sales price by all users; (4) in addition, the law provides that the government should give financial support for the development of renewable energy, such as tax deduction or exemption, interest subsidization etc. [24]. In the same year, the NDRC issued *The Relevant Provisions of Wind Power Construction Projects Management*, requiring the equipments' localization rate of new added wind power projects must reach 70% and all wind power plants not meeting to the requirements of manufacturing localization cannot be allowed to construct [25].

In 2006 the NDRC issued *The Provisional Regulations on Price and Cost Sharing Administration of Renewable Energy Power Generation.* It stipulates that pool purchase price of wind power follows government referential price which is determined by bidding. It also provides that the issue of high pool purchase price can be solved by imposing additional duty on all power users [26].

In 2007 the State Electricity Regulatory Commission (SERC) issued the *Supervision and Administration Methods on Full-scale Purchasing Renewable Energy Power of Grid Companies*. It requires that the grid companies must purchase in full-scale the generating electricity of renewable energy power accessed to the grid [27]. In the same year, *Medium and Long Term Plan for Renewable Energy Development* was released by NDRC. In the renewable plan, the wind power development targets by 2010 and 2020 are set. By 2010, the total installed capacity of wind power can be up to 5 GW, for about 30 wind power plant projects in 100 MW levels can be finished in east coastal areas and Northeast, North and Northwest areas of China, and 3 large wind power plant bases which are up to the level of 1 GW can be founded, in addition, one or two offshore wind power demonstration projects of 100 MW levels can be successfully built up [8]. By 2020, the total installed capacity of wind power can be up to 30 GW, 6 wind power plant bases of 1 GW levels, such as Dabancheng Xinjiang, Jiangsu coast and Western Inner Mongolia can be successfully built up, at the same time, the total installed capacity of offshore wind power can be up to 1 GW [8]. The renewable plan has also provided mandatory market share target for non-hydro renewable energy, the non-hydro renewable energy power must be up to 1 and 3% respectively of the total generation capacity by the end of 2010 and 2020, for all investors owning more than 5 GW capacity, the installed capacity of non-hydro renewable energy must be up to 3 and 8% respectively of the total installed capacity by the end of 2010 and 2020 [8].

In 2008, Ministry of Finance issued the *notice on import tax policies of high-power wind turbine and its key components and raw materials*. The notice stipulates that the import duty and import VAT policies of key components and raw materials for developing and manufacturing high-power wind turbine are paying tax before drawback, the tax refund should be transformed into national investment and used for new production research to strengthen creative capability [28]. The notice also provides that the import

tax of wind power turbines whose rated power are less than 2.5 MW is no longer exempted [28]. In the same year, *the Interim Administration Measures of Special Funds for Wind power Equipment Industrialization* (the interim measures) was released by Ministry of Finance. The interim measures stipulate that the enterprises may get 600 Yuan financial subsidies for each kilowatt, if their wind power turbines or key components are newly developed and achieved industrialization, and the financial subsidy is paid for the initial 50 wind power turbines or key components of units above 1 MW [29]. As converter and bearing are the most critical parts, and relevant manufacturing technologies are long-term at low level domestically, the financial subsidy for key components mainly focuses on them [29].

In 2009 *the Notice on Improving Power Price Policy of Wind Power Accessed to the Grids* was released by the NDRC, stipulating that wind power pricing policy change from tender pricing to benchmarking pricing. According to the condition of wind energy resources and construction, the country is divided into four kinds of wind resource areas, and different benchmark prices are appointed in different areas. The benchmarks of four kinds of wind resource areas are 0.51 Yuan, 0.54 Yuan, 0.58 Yuan and 0.61 Yuan respectively [30]. At the same time, the notice provides that wind power cost-sharing system should continue implementation, and the excess section of pool purchase between wind power and conventional power can be shared by surcharging on nationwide power users [30].

In the beginning of 2010, in order to regulate the construction of offshore wind power projects and ensure healthy development of offshore wind power industry, the National Energy Board and State Oceanic Administration jointly issued the *Interim Measures of Offshore Wind Power Development and Construction*, which includes offshore wind power development planning, project grants, project approval, utilization of sea areas and marine environmental protection etc. This provision provides that national energy authorities are responsible for administering the national development and construction of offshore wind power, and coastal provinces are in charge of administering local projects under the guidance of national energy authorities. The issue of this regulation demonstrates that the Chinese government has begun to plan and regulate large-scale offshore wind power development in the national level [31]. Soon after, *the Revision of Energy Conservation Law* was released. The revision has included a provision of full supported purchasing policy, which requires the grid companies to totally purchase the renewable energy power. To further implement the fully supported purchasing policy, the revision requires SERC and Ministry of Finance to determine the annual targets and implementation plans of purchasing renewable energy power. According to the targets and plans, every grid company's minimum purchasing quota of renewable energy has been determined and announced. In order to ensure the implementation of the purchasing plan, the revision provides that the grid companies are responsible for grid construction and expanding the coverage scope of the grid to improve the capacity of accessing renewable power [32]. In the same year, *the Admittance Standard of Wind Power Equipment Manufacturing Industry* (*draft*) was released by Ministry of Industry and Information Technology, stipulating four conditions of new established wind power equipment manufactory. (1) The proportion of own funds in registered funds cannot be less than 30%; (2) the manufacturer must have necessary production conditions and all facilities capable of manufacturing wind power turbines or components with unit capacity of 2.5 MW and up to annual total capacity of 1 GW; (3) the manufacturer must have more than 5 years experience of large-scale electromechanical industry; and (4) if the manufacturer wants to broaden production capacity, it is necessary to achieve the total installed capacity more than 500 MW [33].

4. Approaches of policies and regulations to promote wind power industry development

During the 11th FYP, the central government has released a series of policies and regulations to promote the development of wind power industry. The main approaches to promote wind industry development can be summarized as follows.

4.1. Supporting localization of wind power equipment

During the 11th FYP, China mainly relies on administrative means and financial subsidies to promote the wind power industry. In 2005, the NDRC compulsively required the localization rate of new wind power projects' equipment must reach 70% [25]. In 2008, Ministry of Finance proposed financial subsidy to promote innovation and technological progress of domestic wind power equipment manufacturers with subsidy at about 600 Yuan/kW. Through these measures, the localization rate of the wind turbine has been rapidly increased and exceeded 70% in 2008.

4.2. Establishing mandatory institution of wind power accessed to the grid

To overcome the bottleneck of wind power development, the central government has always been using mandatory means and built mature mandatory institution. In 2006, the government released *The Renewable Energy Law* and required the grid companies to fully purchase renewable energy power. Soon after, the NDRC clearly stipulated that large accessed grid constructions and projects of wind power should be invested by the grid companies and partly be subsidized by government. In 2010, the Revision of *Energy Conservation Law* further refined the mandatory institution. The revision stipulates that the grid companies should strengthen power grid construction to ensure that all wind power can be accessed to the grid. It also requires NDRC to establish supportive full purchasing system and determine every grid company's minimum quotas of wind power.

4.3. Formulating mandatory targets of wind power quotas

In 2007, *Medium and Long Term Plan for Renewable Energy Development* was released by NDRC. The plan requires using the method of mandatory quota to promote the development of renewable energy. The plan stipulates that any generation companies, if their total installed capacity has up to 5 GW, should do their best to develop renewable energy power industry and make the portion of renewable energy power (not including hydropower) in total installed capacity up to 3% by 2010 and 8% by 2020. Among all renewable energy (not including hydropower) technologies, wind power is the most mature with the lowest cost, so all power generation companies choose wind power to achieve the quota requirement.

4.4. Providing subsidy and tax support

Subsidy Policy is an important method to promote the development of wind power. To solve the issue of high price, the central government requires the price difference between wind power and conventional energy power to be shared by all powers accessed to the grid. So the surcharge of 0.002 Yuan/kW has begun to be charged from 2006, and soon after the surcharge has risen to 0.004 Yuan/kW. During the 11th FYP, the total subsidy for wind power is about 18 billion Yuan and 95% of all wind power projects have benefited from it [34]. In addition, the central government has also used tax-exemption policies to improve the external environment of wind power development, so the VAT rate has been

reduced from normal of 17 to 8.5%, and the income tax rate of wind power projects from normal of 33 to 15%.

5. The shortcomings of current policies and implementation

5.1. Lack of incentives for grid companies

In order to improve the proportion of wind power accessed to the grid, various measures have been taken to promote grid companies to increase the investment and expand the coverage of the grid, but those measures are mostly command and control types with less economic incentive. Due to shorter utilization time, unstable load and additional backup power supplies for peak regulation related with wind power, the operation cost of grid has been greatly increased, so it is inefficient to use mandatory measures alone. To fundamentally solve the problem of wind power grid-access, it is necessary to adopt economic measures and increase financial subsidies. Only if sufficient funds and subsidies have been put into the grid companies, the initiative of power gird construction can be mobilized.

5.2. Insufficient support for independent innovation

To support the development of domestic wind power equipment manufacturing, central government released mandatory regulation about equipments' localization rate of new added wind power projects, and then Ministry of Finance began to implement the regulation of financial subsides and tax deduction and exemption for wind power equipment manufacturing, so the localization rate of wind power equipments has rapidly increased. But in fact, the implementation of those regulations has not fundamentally solved the problem of lacking of core competence in wind power equipment manufacturing industry. China is lacking the ability of independent innovation. As noted by some field experts, wind turbine is mainly constituted by 15 kinds of components, among which 8 need to be imported from abroad or purchased from foreign-direct-invested enterprises. Though many components such as gear boxes and blades can be produced by domestic enterprises, there is a great gap regarding policy issues between domestic and foreign products. The current price of wind turbine is about 4200 Yuan, among which 1200 Yuan is paid for the royalty to the patent owners [35]. In addition, because of the pressures from foreign governments, the mandatory regulation about equipments' localization rate and financial subsidies has also been cancelled. Therefore, it cannot solve the issue of lacking core competence only relying on tax deduction and exemption. Generally lots of talent and vast capital investment are needed to carry out independent innovation, which is always beyond the capability of a single company. So it is of vital importance that the government initializes to organize comprehensive R&D programs and provide strong and long-lasting financial support to these activities.

5.3. Lacking of coordination between different government departments

During the 11th FYP, a variety of conflicts have gradually emerged when promoting wind power development in China. Firstly, the attention of development is uncoordinated between central government and local government. The focus of central government is comprehensive in different aspects including the total installed capacity, the regional distribution, and the construction of in-access grid while local governments mainly consider the scale and speed in their region and pay no attention to the development of wind-access power grid. So many wind power plants have been built but not in accordance with the national general planning, resulting in a considerable idling of wind power. Secondly, there is inconsistency of development policy orientation between energy authorities and Ministries in charge of industry. The energy authorities mainly focus on the scale of installed capacity and advocate that financial subsidies should mainly be distributed to the construction of wind power plants. But the authorities in charge of industry maintain that the policy should focus on the technological progress and advocate that the financial subsidies should mainly be distributed to technology R&D and equipment manufacturing sectors. It has resulted in the evolving contention between scale and technology. Finally, it is the lack of coordination between government and industry, which is mainly reflected in price. The government maintains a fixed price, but industry advocates the use of market mechanisms to regulate the price. This lack of coordination has led to the current confusion of installed capacity and equipment manufacturing, endangering the healthy development of the wind power industry.

6. Policy outlook

In 2010, the developing pace of wind power has begun to slow down. In the 12th FYP period, the development mode of wind power industry should be changed from extensive style to intensive one, with the focus on balanced development between quality and quantity. One important reason why wind power industry has rapidly developed in past five years is that polices and regulations have provided sufficient support. So in order to adapt to the new developing situation and new trend of wind power industry, polices should be adjusted timely. We hereby propose policy recommendations as follows.

6.1. Setting up Renewable Energy Fund timely

The central government should release accumulation and management policy on renewable energy fund, establish renewable energy fund and broaden the sources of fund as soon as possible. The main source of the fund is the surcharge added in power price, but the government should also provide sufficient financial subsidies. The application of the fund should not be limited to provide price subsidies for renewable energy companies to reduce price gap between conventional energy and renewable energy. Moreover, it should be used as subsidies and incentives for grid companies to accelerate the pace of power grids construction.

6.2. Improving pricing mechanism for wind power

The government should deregulate the wind power price and seek a new way to use market mechanisms to formulate reasonable price system which can reflect the differences between conventional energy and renewable, promote technological progress and be conducive to the development of wind power industry.

6.3. Releasing and implementing more market-oriented economic policies

Firstly, the quota system should be further developed and improved to expand the market scope of renewable energy generation. Secondly, the legislations on market mechanisms, including carbon tax, energy tax, resource tax, pollutant emission tax, environment tax and product technology standard etc. should be formulated or reformulated to systematically promote and standardize renewable energy utilization. Finally, the overall goal of using wind energy can be broken down into different quotas and assigned

to all regions, and at the same time it should try to establish a market trading system to promote quotas trading of different areas.

6.4. Building up national level energy science R&D platform

In the first place, the government should enlarge input in basic research and improve the capability of independent innovation. Secondly, the national level R&D institution, which is led by government and widely participated by enterprises, should be built up for the research on key technologies and key components, such as bearings, temperature sensors, hydraulic pump, and control system. Moreover, the detailed development roadmap for them should be drafted. Once more, a special fund to develop new energy technology should be established to support technology R&D and demonstration projects for breakthrough in technological-economics bottleneck, education of talents and enhancement of core competency.

Acknowledgement

The authors are grateful to the fund of Ministry of Education of China (10YJC790360). The usual *caveats* apply.

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